PULMONARY GAS EMBOLISM
(DECOMPRESSION SICKNESS)

A. GENERAL CONSIDERATIONS

Decompression is an operational hazard for divers. The condition results from the escape of gases from the blood and other tissues during ascent.

B. ESSENTIALS OF DIAGNOSIS

1. Recent history of diving or exposure to pressure.
2. Highly variable symptoms occur within 30 minutes in 50% of the patients and invariably within 6-24 hours.
3. Type I - usually joint pain.
4. Type II - CNS involvement
5. Pruritic rash
6. Visual disturbances
7. Weakness or paralysis
8. Dizziness, vertigo and headache
9. Dyspnea and/or aphagia, coughing
10. Coma

C. LABORATORY TESTS

1. None

D. LABORATORY FINDINGS

1. None

E. COMPLICATIONS

1. Cardiopulmonary arrest
2. Permanent neurologic or cardiac damage

F. TREATMENT

1. ABC's and CPR as needed.
2. Give oxygen at 3-4 liters via mask.
3. You may need to perform a needle cricothyroidotomy or intubate (refer to the section covering these procedures).
4. Give aspirin or Tylenol for pain. Do not give anything stronger (may obscure the patients response to recompression).
5. Rapidly transport the patient to the nearest decompression Chamber.
6. Start an IV and support vital signs.
7. Administer Decadron 10mg IV if the patient is comatose.

G. DISPOSITION

1. Early recognition and rapid transport to a chamber is the only treatment.

DROWNING

A. GENERAL CONSIDERATIONS

Death in drowning ensues from asphyxiation, usually due to aspiration of fluids, but it may result from airway obstruction caused by laryngospasm while the victim is gasping underwater.

B. ESSENTIALS OF DIAGNOSIS

1. The following sequence of events will occur within 5-10 minutes after submersion; the sequence will take longer if the victim , especially a child, is submerged in very cold water:

   a. Fluid aspiration/laryngospasm
   b. Hypoxemia
   c. Ineffective circulation
   d. Brain injury/brain death

2. The signs and symptoms of near-drowning include:

   a. Loss of consciousness or semiconsciousness
   b. Seizure
   c. Headache and chest pain
   d. Vomiting
   e. Trismus
   f. Respiratory abnormalities:

      1) apnea
      2) tachypnea
      3) wheezing
      4) pink frothy sputum from pulmonary edema
      5) some patients show a delayed respiratory failure in 12-24 hours.

   g. Cardiac abnormalities: arrhythmias, tachycardia, hypotension, arrest, cardiogenic shock.

C. LABORATORY TESTS

1. Urinalysis

D. LABORATORY FINDINGS

1. You may see proteinuria and ketonuria

E. COMPLICATIONS

1. Cardiopulmonary dysfunctions including: pulmonary edema, arrhythmias, cardiopulmonary arrest.
2. Brain injury
3. Metabolic acidosis

F. TREATMENT

1. Begin CPR if needed. Use mouth-to-mask initially.
2. Give oxygen at 6-8 liters/minute via mask or nasal canula.
3. If you are unable to ventilate (initially) using good CPR techniques or ASAP after CPR is begun, intubate the patient. This not only allows for better exchange of air, but prevents aspiration of fluids from the stomach. If you do not have intubation equipment, then perform a needle cricothyroidotomy. Remember that a needle cricothyroidotomy only provides a good airway for about 30 minutes (then CO_2 retention becomes a major factor).
4. If the patient was hypoxic for more than 4 minutes, give Dexamethasone to reduce cerebral edema. Give 10mg slowly. Contact a Medical Officer prior to administration when possible.

5. Place a nasogastric tube and remove fluids from the stomach.
6. Insert a Foley catheter and monitor output.
7. Give IV Aminophylline if wheezing is present. Give 250-500mg in 20cc D_5W over 20 minutes.

D. DISPOSITION

1. Contact a Medical Officer as soon as the patient is stabilized and prepare for MEDEVAC.

FROSTBITE

A. GENERAL CONSIDERATIONS

Frostbite is a graded tissue injury resulting from exposure to low environmental temperatures (especially dry cold below freezing). The extent of the injury depends primarily on the temperature and the length of exposure. The injury is a direct result of the interruption of blood supply and the freezing of intracellular & extracellular fluid (which disrupts & destroys cell membranes). People who are more likely to develop frostbite are: those with a prior history of frostbite, blacks, those from warm climates, smokers and those who use alcohol.

B. ESSENTIALS OF DIAGNOSIS

1. Superficial frostbite results from exposure to low temperatures and involves only the skin and immediate underlying tissues. Deep frostbite results from extremely low temperatures or longer exposure. It also involves the subcutaneous tissues and deeper layers.
2. Symptoms are variable. Most feel pain initially, followed by a loss of sensation. Some never feel pain. Others feel pain throughout. Keep in mind that this injury is often seen in association with hypothermia and the patient may not be aware of the injury or his level of consciousness may be impaired.
3. The skin first turns red then pale or waxy white.
4. In superficial frostbite, the skin feels cold, resilient, and edematous; it is freely movable over bony prominences.
5. In deep frostbite, the skin appears translucent, waxy, pale, and yellow. Cyanosis, severe edema, large bullae and thrombosed superficial vessels will be evident (in time). The skin feels solid or wooden; the subcutaneous tissues are bloated. The skin is not movable over the bony prominences.
6. After thawing:

   a. Aching or burning pain will persist; lack of pain or sensation may persist after deep frostbite.
   b. Large bullae develop (in deep frostbite), which dry and become hard scabs.
   c. Damaged skin will blacken and slough, leaving a thin layer of sensitive new skin.
   d. Damaged subcutaneous tissues will either dry and mummify or necrose and become infected.

C. LABORATORY TESTS

1. None

D. LABORATORY FINDINGS

1. None

E. COMPLICATIONS

1. Infection
2. Progressive cold injuries

F. TREATMENT

1. Rapidly rewarm the affected part in a water bath (or whirlpool) at 104 - 107^{0}F. Rewarming usually takes 20-40 minutes. The viable tissue goes from a pale color to flushed. Continue rewarming until no further color change occurs.
2. Aspirin is the drug of choice for pain relief since it may also help improve the circulation. Remember that the largest portion of the tissue damage occurs from the lack of/or poor circulation. Stronger drugs for pain relief should be added as needed.
3. Do not massage or rub the affected parts, rupture bullae, or apply tight dressings.
4. Place cotton pledgets between digits to control interdigital contact and pressure.
5. Place patient on absolute bed rest, protecting the affected parts from pressure from bedclothes. Elevate the affected parts.
6. Give antibiotics if necrosis is severe and secondary infection is probable.
7. Give high caloric diet with ample fluids.
8. The patient should not smoke.

9. After thawing has been completed, the patient must still be considered to be a litter patient. Thawing and refreezing does more damage than walking on a frozen extremity (keep this in mind when deciding to thaw an extremity when in a position where you can not make this patient a litter patient and they will have to walk).
10. Treat the area with the same attention to aseptic technique as with a burn.

G. DISPOSITION

1. Contact a Medical Officer ASAP and prepare for possible MEDEVAC.
2. If you find yourself in a unique situation where you can not make the victim a litter patient and protect them from refreezing - do not thaw the affected part.

H. PREVENTION

1. Avoid tight clothing
2. Avoid nicotine and alcohol
3. Protect the exposed areas (nose, eyes). This includes the use of goggles for the eyes.

HEAT CRAMPS

A. GENERAL CONSIDERATIONS

Heat cramps occur when the body fails to adequately replace the Sodium Chloride lost by profuse sweating as a result of heavy work or temperatures above 100^{0}F. Heat cramps are more likely to occur in unacclimated patients. Heat cramps are usually not accompanied by an increase in core temperature.

B. ESSENTIALS OF DIAGNOSIS

1. Sudden onset of cramp-like muscle spasms, most frequently affecting the flexor and abdominal muscles.
2. Pain may be severe
3. Skin is pale and wet
4. Body temperature and blood pressure are normal

C. LABORATORY TESTS

1. None

D. LABORATORY FINDINGS

1. None

E. COMPLICATIONS

1. Heat exhaustion

F. TREATMENT

1. Move the patient to a cool area.
2. Loosen clothing, but do not remove. Keep the patient supine.
3. Administer 1,000cc of normal saline IV slowly and give cool water PO.
4. Excuse the patient from duty for 24 hours.

G. DISPOSITION

1. Contact a Medical Officer if complications develop.

HEAT EXHAUSTION

A. GENERAL CONSIDERATIONS

Heat exhaustion results from the failure to adjust to the dilation of skin blood vessels, the body's primary response to increased temperatures. Alcohol intake, excessive sweating, vomiting, diarrhea, or other forms of dehydration increase the probability of occurrence. Probably the most common heat syndrome.

B. ESSENTIALS OF DIAGNOSIS

1. Skin is ashen, cold, and damp; sweating may be profuse.
2. The body temperature may be normal or slightly elevated.
3. Blood pressure is decreased, and the pulse is about 100.
4. Weakness, dizziness, vertigo, nausea, headache, visual disturbances, mild muscle cramps, listlessness and apprehension are common findings.

C. LABORATORY TESTS

1. CBC
2. Urinalysis

D. LABORATORY FINDINGS

1. You may see increased hematocrit and WBC due to hemoconcentration.
2. The specific gravity usually over 1.030.

E. COMPLICATIONS

1. Shock

F. TREATMENT

1. Move the patient to a cool area.
2. Loosen the clothing, but do not remove. Keep the patient supine.
3. Administer 1,500 - 2,000cc normal saline slowly; give PO water if the patient has no impairment of sensorium.
4. Observe closely for circulatory collapse.

G. DISPOSITION

1. Contact a Medical Officer if the patient fails to respond rapidly or if complications develop.

HEAT STROKE

A. GENERAL CONSIDERATIONS

Heat stroke results from a profound disturbance of the heat regulating mechanisms, and is characterized by high fever, collapse, convulsions, coma, and eventual death. It usually follows prolonged exposure to high temperatures and strenuous physical activity in a hot environment. Contributing factors are old age, poor ventilation, poor nutrition, dehydration, cardiovascular disease, chronic alcoholism, obesity, febrile illnesses and general disability. Patients using diuretics, sedatives or anticholinergics are also at risk. Heat stroke is a true medical emergency that requires heroic measures for successful treatment.

B. ESSENTIALS OF DIAGNOSIS

1. Onset may be sudden, or the patient may experience a prodromal phase of weakness, vertigo, anorexia, headache, or precordial distress.
2. Sweating decreases, or ceases, and the skin is flushed, hot and dry.
3. Spiking fever may be as high as 105 - 106^{0}F. (it has been reported to go as high as 112^{0}F).
4. Pulse is commonly greater than 140, respirations are 20-30, and blood pressure is elevated with a wide pulse pressure.
5. Pupils are constricted early but dilated later.
6. Renal or cardiac failure may occur secondary to hyperkalemia.
7. Convulsions and projectile vomiting may occur.
8. Irreversible shock may ensue.
9. A loss of consciousness with a lower (ex 102^{0}F) temperature is still considered to be a heat stroke.

C. LABORATORY TESTS

1. Urinalysis
2. CBC

D. LABORATORY FINDINGS

1. Increased specific gravity
2. WBC and hematocrit may be elevated due to hemoconcentration

E. COMPLICATIONS

1. Cardiopulmonary and/or renal failure

F. TREATMENT

1. Maintain airway and give oxygen at 6-8 liters/minute.
2. Move the patient to a cool area and rapidly cool the patient with ice water baths or sheets soaked in ice water until the temperature is less than 101^{0}F. If the temperature does not fall, administer ice cold saline enemas (1,500 - 3,000cc).
3. Monitor vital signs q 10 minutes (or more frequently as the situation warrants).
4. Massage the patient vigorously to maintain peripheral circulation.
5. Give Thorazine to control intense shivering.
6. Start IV fluids to maintain circulatory flow. Give 2,000cc of normal saline slowly.
7. Treat seizures with Diazepam (10mg slow IV push q 30 minutes as needed).

G. DISPOSITION

1. Stabilize and MEDEVAC this patient ASAP.

HYPOTHERMIA

A. GENERAL CONSIDERATIONS

Hypothermia is simply a lowering of the body's normal core temperature. Significant hypothermia begins at a core temperature below $35^{0}C$, and severe hypothermia occurs at core temperatures below $31^{0}C$. Nearly all physiologic functions are slowed (heart rate, respiratory rate, metabolic rate, mentation and reflexes). This involves ALL organ systems.

B. SYMPTOMS

The most important signs are readily observed:

1. Bradycardia
2. Bradypnea
3. Altered mental status (slurred speech, staggered gait, diminished response to painful or verbal stimuli, or unconsciousness).
4. Cold skin
5. Low core temperature

They may have other changes going on that are not so easily detected:

6. Serum electrolyte imbalances
7. Alterations of blood gases
8. Dysrhythmias
9. Dehydration
10. Temperature gradients between deep and superficial tissues.

THE PRIMARY GOALS ARE TO PREVENT CARDIOPULMONARY ARREST, TO STABILIZE CORE TEMPERATURE, AND TO TRANSPORT THE PATIENT TO A SITE OF DEFINITIVE CARE.

C. RESCUE

Always maintain a horizontal position when possible. This is to preserve cerebral blood flow. This becomes even more important when removing someone from the water. The hydrostatic pressure of the surrounding water acts as MAST trousers. Removing the patient from the water is similar to suddenly removing MAST trousers. It is important, therefore, to make all reasonable attempts to maintain the patient a horizontal position in this situation. If this is not possible, get the patient in the supine position ASAP after removal from the water.

D. EXAMINATION

1. ABC's. It may take up to a full minute to measure the vital signs due to the slowing effects of the hypothermia.
2. CPR if needed. Mouth-to-mouth or mouth-to-mask is the preferred method due to the heated/humidified gas it provides.
3. Hypothermia patients with any measurable pulse or respiration DO NOT require CPR even though they may have extreme bradycardia/ bradypnea/ hypotension. The metabolic needs are reduced in the hypothermia patient and the tolerate these low rates. The cold myocardium, on the other hand, is very irritable and inappropriate CPR may precipitate ventricular fibrillation. If both pulse and respirations are absent after one minute, begin CPR. If the patient is found face down in the water, begin CPR in the usual manner. This must be considered cold-water-near-drowning and hypoxia must be corrected before the hypothermia is treated.
4. Even if you had ACLS capabilities, you would need to warm the patient first.
5. Note the mental status: level of consciousness, pupillary size and light reflex, response to painful or verbal stimuli, ability to think clearly, and gait. If any of these are abnormal, hypothermia should be in you differential (remember, it may not always be obvious that a patient is suffering from hypothermia).
6. Check closely for other injuries (hypothermia patients have a reduced response to pain).

7. Measure vital signs: pulse respirations, blood pressure, temperature. Core temperature measurements are essential! Use a rectal thermometer that is capable of reading in the range of hypothermia. If this can't be done, use a low reading thermometer to take axillary or oral readings. While these readings are not as good, you do have an approximation of the core temperature. The use of a normal clinical thermometer is inappropriate since it can only measure to 34^0C.
8. Control hemorrhage in the usual manner. Only use MAST trousers if the hypotension is known to be secondary to hypovolemia. Hypotension is common in hypothermia, and the application of MAST trousers could force a sudden bolus of cold venous blood to the heart resulting in ventricular fibrillation.
9. Handle the patient very carefully. Excessive mechanical stimulation can cause ventricular fibrillation due to the irritable myocardium.

E. INSULATION

1. Prevent further heat loss. Remove wet clothing. Shield the patient from the wind.
2. Gently add heat. Active rewarming is frequently complicated by dysrhythmias, electrolyte imbalances etc.. Some useful techniques are:

   a. Administration of heated/humidified oxygen ($40-42^0$C).
   b. Application of heat (hot packs, warm towels etc.) to the head, neck, axilla and groin. These heat sources must be insulated from the patients body in order to prevent thermal injuries. Remember that hypothermic skin is easily injured.
   c. Transfer of body heat by the buddy system (when other means are not available).
   d. The patient should remain NPO. This is not needed in the very mild cases of hypothermia.
   e. Administration of warm IV fluids. Use D_5NS or NS. Avoid LR because the hypothermic liver may not be able to metabolize the lactate normally.
      Most hypothermic patients are dehydrated, therefore give them a 500cc bolus followed by 125cc/hr. Bring the IV to normal body temperature (you can do this by running the tubing through a bucket of warm water).
   f. DO NOT allow the patient to smoke, as this causes vasoconstriction.
   g. Warm water enemas.
   h. Place the patient in warm water (40^0C). The patients arms and legs should NOT be in the water.

F. DISPOSITION

1. Contact a Medical Officer ASAP for further instructions and possible MEDEVAC.

DEATH IS NOT CERTAIN UNTIL THE CORE TEMPERATURE IS RETURNED TO NORMAL LIMITS

IMMERSION FOOT

A. GENERAL CONSIDERATIONS

Immersion foot is a tissue injury of the feet, resulting from prolonged exposure to wet cold at temperatures above freezing. The tissue response results from the action of cold, wet surfaces against the skin, combined with circulatory disturbances due to cold and inactivity. The exposure causes venous stasis, circulatory pooling, and general body chilling.

B. ESSENTIALS OF DIAGNOSIS

1. The symptoms are variable. The most common are numbness, paraesthesias and pain.
2. Physical findings are best classified by the features:

   a. Minimal - reddening of the skin; slight sensory change.
   b. Mild - swelling; sensory changes (reversible)
   c. Moderate - swelling, redness, blebs, and intracutaneous hemorrhages; irreversible nerve damage.
   d. Severe - severe swelling, blebs, massive bleeding into the skin and other tissues; gangrene.

C. LABORATORY TESTS

1. None

D. LABORATORY FINDINGS

1. None

E. COMPLICATIONS

1. Infection
2. Gangrene
3. Phlebitis

F. TREATMENT

1. Remove wet footgear and allow feet to air dry; DO NOT rewarm rapidly or massage feet with towels.
2. Patient should be placed at bed rest with feet elevated and protected from bedclothes.
3. Blisters should NOT be ruptured; the area should be kept clean and dry and dressed with a sterile fluff dressing loosely applied.
4. Relieve pain with analgesics.
5. Give Penicillin or Erythromycin prophylactically.
6. Give Tetanus Toxoid booster.
7. The patient should NOT smoke!

G. DISPOSITION

1. Contact a Medical Officer if complications occur or symptoms do not resolve in 48 hours (for minimal or mild cases). Contact a Medical Officer for all moderate or severe cases.

POISONING

A. GENERAL CONSIDERATIONS

Poisoning is the accidental or intentional introduction of any poisonous substance into the body via ingestion, absorption or inhalation. The assessment and management of poisonings requires the appropriate use of references such as the Physician's Desk Reference (PDR), or the Handbook of Poisoning: Prevention, Diagnosis, and Treatment.

Most poisonings do not have specific antidotes. Regardless, attempt to identify the poison. Treatment of the ABC's takes precedence over specific antidotes. Supportive care is of paramount importance. In general, you should follow the treatment plan outlined below:

1. Remove the patient from further exposure
2. Vigorous supportive care
3. Aid excretion as much as possible - without overhydration
4. Neutralize toxins with specific antidotes as available
5. Save all samples for later analysis
6. Keep in mind the legal implications of poisonings
7. Many poisonings are unknown to the patient and others will not be admitted. Poisoning, therefore, should be part of many of your differential diagnoses.

B. ESSENTIALS OF DIAGNOSIS

1. Exposure to a known, unknown or possible poison has occurred.
2. The degree of exposure is sufficient to cause physiological harm and to warrant emergency care.
3. A known minimal lethal dose has been met or exceeded.
4. Signs and symptoms of a disorder caused by environmental or intentional exposure to known poisons or toxins are evident.
5. Common signs of representative poisons are:

    a. Tachycardia - Amphetamines, Cocaine, Atropine
    b. Bradycardia - Organophosphates, Beta-Blockage
    c. Hyperthermia - Amphetamines, Cocaine, PCP, Atropine
    d. Hypothermia - Barbiturates, Alcohol, Narcotics, Sedatives
    e. Hyperventilation - Salicylates, Caffeine, Theophylline
    f. Respiratory Depressants - Barbiturates, Narcotics, Sedatives, Organophosphates
    g. Hypertension - Amphetamines, PCP, Cocaine, Nicotine
    h. Hypotension - Iron, Narcotics, Barbiturates

C. LABORATORY TESTS

1. Refrigerate all samples of emesis, urine and blood for later analysis
2. WBC
3. Urinalysis

D. LABORATORY FINDINGS

1. To confirm the identity of the poison
2. Watch for bone marrow suppression (baseline)
3. Watch for renal impairment (baseline)

E. COMPLICATIONS

1. This can run the full spectrum from minor injury to death. The outcome depends upon the dose, the poison involved, the time since exposure, existing medical problems etc..

F. TREATMENT

1. REMOVAL FROM FURTHER EXPOSURE

   a. Absorbed poisons

      1) Remove all contaminated clothing
      2) Flush areas with large amounts of water
      3) Consider the use of gloves for strong toxins

   b. Ingested toxins

      1) The key is to take steps to reduce absorption
      2) Emetics - use syrup of ipecac to induce vomiting. Repeat in 15 mins, if no results (only once). If still without results after 30-40 minutes, use gastric lavage. Remember that aside from not removing the poison, that syrup of ipecac is somewhat toxic in itself. Induction of vomiting with a full stomach is the preferred method of evacuation. This also allows for large particles to be removed. DO NOT use fluid Extract of Ipecac (it is on the order of tens times stronger).

DO NOT INDUCE VOMITING IF: THERE IS A LOSS OF THE GAG REFLEX, EVIDENCE OF CORROSIVE ALKALI OR HYDROCARBON INGESTION OR WITH A PATIENT WITH REDUCED LEVEL OF CONSCIOUSNESS.

      3) Gastric lavage - remember that this can induce vomiting with resultant aspiration. Careful positioning and availability of suction is mandatory.

DO NOT USE GASTRIC LAVAGE IF: THERE HAS BEEN INGESTION OF A CORROSIVE ALKALI.

      4) Adsorption - activated charcoal is the preferred method. DO NOT give with the emetic or antidote as it will absorb them too.
      5) Precipitation - older methods are not viable. Use Activated Charcoal as above instead.
      6) Cathartics - Magnesium Sulfate reduces the time spent in the intestines and, therefore, reduces absorption.
      7) Start a large bore IV to increase excretion of the poison (500cc bolus of LR followed by 125-150cc/hr).

   c. Inhaled poisons

      1) Remove from exposure
      2) Assist respirations as needed
      3) Supportive care

2. Other considerations of treatment

   a. Start a large bore IV to increase the excretion of the poison.
   b. Cerebral edema - classically seen in Lead, Methanol and Carbon Monoxide Poisonings. Consider the use of Adrenocortical Steroids.
   c. Generally, the use of Baking Soda (for acids) and Vinegar (for alkalies) is discouraged. This is due to the intense exothermic reaction (ie heat).
   d. For ingestions, always follow with large amounts of water.

3. Supportive care

   a. Support vital functions. You may need to bag or intubate the patient (see the section concerning intubation).

G. DISPOSITION

1. Contact a Medical Officer for further advice and possible MEDEVAC.
2. Always MEDEVAC with ingestion of corrosive alkalies.